

**OBSERVATIONS ON THE BEHAVIOR OF *MACHIMUS OCCIDENTALIS*
(HINE) AND *MACHIMUS FORMOSUS* (HINE) (DIPTERA: ASILIDAE)
IN MONTANA**

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Abstract.—In Montana, *Machimus occidentalis* (Hine) is a typical free-ranging grassland asilid, whereas *Machimus formosus* (Hine) centers its activities around the entrances of small mammal burrows. Their divergent microhabitat preferences are reflected in differences in their thermoregulatory, mating, and foraging strategies. Both species are opportunistic predators that take a wide range of prey taxa and sizes.

Key Words: robber fly, Asilidae, prey, mating

On western U.S. grasslands, robber flies of the asilid genus *Machimus* display two general types of microhabitat preference (James 1941, Lavigne 1968, Dennis and Lavigne 1979, O'Neill and Kemp 1992). *Machimus gilvipes* (Hine) and *M. formosus* (Hine) restrict most of their activities to the vicinity of the burrows of small mammals, spending much of the day perched on the walls of the burrows. *Machimus callidus* (Williston) and *M. occidentalis* (Hine), in contrast, are more typical grassland asilids that range relatively freely across their habitats, perching on bare ground or low plants. In Wyoming, Lavigne and his colleagues have studied all four species, with particular attention to *M. gilvipes* (Rogers and Lavigne 1972, Lavigne 1968, Schreiber and Lavigne 1986) and *M. callidus* (Dennis and Lavigne 1979). Working in Montana, O'Neill (1994, 1995) reported several prey records for *M. occidentalis*, and O'Neill and Kemp (1992) reported on the thermoregulatory behavior of *M. formosus* and *M. occidentalis*. Here, I report on further behavioral observations and prey records of these two species.

METHODS

Machimus occidentalis, a gray robber fly 13–17 mm long, was studied on 36 days during June and July of 1988–1994. Most observations were made in several gullies 14 km south of Three Forks, MT. One gully was dry, with vegetation dominated by grasses such as *Stipa comata* Trin. and Rupr., *Bouteloua gracilis* (H.B.K.) Lag., and *Bromus tectorum* L., with scattered shrubs (especially *Rhus trilobata* Nutt.). The other gully, about 1 km to the south was more mesic, and contained a large patch of lupine (*Lupinus* sp.) mixed with grasses. *Machimus formosus*, a yellowish-brown species 11–15 mm long, was observed on 13 days from late June-early August in 1988–1991 at a grassland site 10 km south of Three Forks dominated by crested wheatgrass (*Agropyron cristatum* L. (Gaertn)). Here, the sizes of the robber flies are reported as maximum head width, whereas those of prey are given as body length or as the product of body length and thorax width. The latter was used in analyses as a simple two-dimensional index of prey size that accounts for variation in prey shape. Prey

mass was not used because prey were collected after the robber flies had fed for unknown periods of time when prey were collected.

RESULTS AND DISCUSSION

Machimus occidentalis (Hine)

Machimus occidentalis ambushed prey in mid-air after flights about 10–30 cm long initiated from perches on the ground or on low plants. The 125 prey collected included insects from 29 families in eight orders (Fig. 1) (sample sizes are given where $N > 1$): EPHEMEROPTERA, Leptophlebiidae: *Paraleptophlebia* sp.; Baetidae: unidentified sp.; ORTHOPTERA, Acrididae: *Melanoplus sanguinipes* (F.) (nymph), *Phlibostroma quadrimaculatum* (Thomas) (nymph); HOMOPTERA, Cicadellidae: *Philaronia bilineata* (Say), *Prairiana subta* Ball (3), *Psammotettix lividellus* (Zetinger) (2), unidentified sp. (2 nymphs); Aphididae: unidentified sp.; HEMIPTERA, Miridae: *Leptopterna ferrugata* (Fallen), *Litomiris debilis* (Uhler); LEPIDOPTERA, Geometridae: unidentified sp.; Lycaenidae: *Lycaenides* sp.; Pyralidae: *Crambus* sp.; COLEOPTERA, Chrysomelidae: *Cryptocephalus notatus* F.; Scarabaeidae: *Serica anthracina* LeConte, *Aphodius vittatus* Say, *Aphodius distinctus* (Mueller), *Dichelonyx backii* (Kirby) (15); Elateridae: *Ctenicera glauca* (Germar); DIPTERA, Anthomyiidae: *Paregle cinerella* (Fallen); Asilidae: *Machimus occidentalis* Hine (5); Athericidae: *Atherix pachypus* Bigot; Calliphoridae: *Phormia regina* (Meigen); Chironomidae: unidentified sp. (3); Milichiidae: *Pholeomyia indecora* (Loew), Sarcophagidae: *Acridophaga* spp. (4), *Arachnomyia* sp. (2), *Blaesoxipha opifera* (Coquillett), *Protodexia hunteri* (Hough), *Ravinia iherminieri* (Robineau-Desvoidy) (2), unidentified sp.; Sepsidae: *Sepsis* sp.; Simuliidae: *Simulium* sp. (3); Stratiomyiidae: *Sargus cuprarius* (L.); Tabanidae: *Chrysops mitis* Osten Sacken; Tachinidae: *Besseria brevipennis* (Loew), *Chetogena tachinomoides* (Town-

send), *Frontiniella parancilla* Townsend, *Ptilodexia rufipennis* (Macquart), unidentified sp. (2); Tipulidae: *Tipula* sp.; unidentified family; HYMENOPTERA, Formicidae (all alates): *Formica ciliata* Mayr, *Formica subpolita* Mayr (40), *Formica* sp. (3), *Lasius* sp. (2); Halictidae: *Lasioglossum* sp.; Ichneumonidae: *Anomalon reticulatum* (Cresson), unidentified sp.; Mutillidae: unidentified sp.. Nineteen of the ant prey and six of the cannibalism records were previously reported in O'Neill (1992, 1994).

Machimus occidentalis took a wide range of prey sizes relative to their own body size, from an aphid just over 1 mm long, to flies and ants 10–16 mm long (Fig. 1), but there was no correlation between predator and prey size ($r_s = 0.05$, $P = 0.59$, $N = 106$). Prey records from a particular site and time were often quite uniform. For example, on 8, 9, and 12 June 1992 in the south gully, 25 of 31 prey were either large tachinids and sarcophagids ($N = 10$) or the beetle *Dichelonyx backii* ($N = 15$). However, on 10, 19, and 21 June 1992 in the north gully, 21 of 26 prey were alates of the ant *Formica subpolita*, males of which commonly formed mating swarms in the vicinity and provided a flush of resources for predators in the area (O'Neill 1994).

As with foraging, the mating strategy of male *M. occidentalis* consisted of ambushing females passing in flight, without conspicuous courtship. Each coupled pair immediately descended to low plants, the male always remaining mounted dorsally on the female during copulation. Males (mean \pm SE head width = 3.14 ± 0.02 mm) tended to be larger than their mates (mean = 2.96 ± 0.02) ($N = 43$, Wilcoxon signed rank test, $P < 0.001$).

Machimus formosus (Hine)

As in Colorado (James 1941) and Wyoming (Lavigne 1968), *M. formosus* centers its activity around burrow entrances of small mammals, which at the Montana site were made by badgers (*Taxidea taxus*) and ground squirrels (*Citellus* sp.). When the

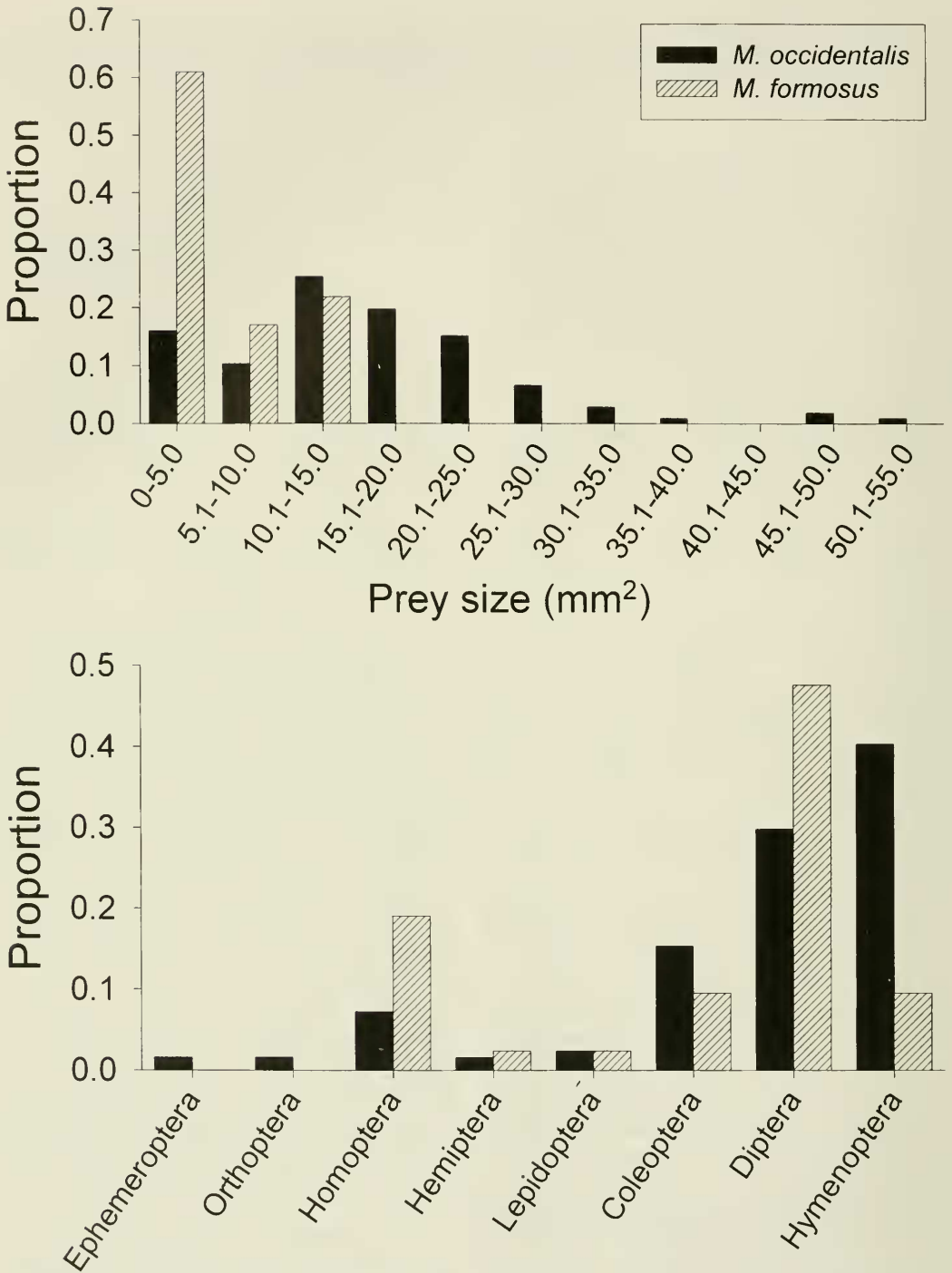


Fig. 1. Top: range of prey sizes (area in 5 mm² increments) used by the two species; bottom: frequency distributions of prey orders used by *M. occidentalis* and *M. formosus*.

flies first became active each day, they perched on fully insolated level soil outside of burrow entrances, but as soil surface temperatures rose above about 32°C, they began perching on the walls of burrows, down to depths of 14 cm (O'Neill and Kemp 1992). During several surveys of the surrounding grasslands, I observed an *M. formosus* away from the burrows only once. However, they were often common at burrows. On 16 July 1989, 38 of 100 burrows were occupied by individual *M. formosus*. Two days later, 42 of 100 burrows were occupied, 21 by a single male, six by a single female, 13 by flies of undetermined sex, and two by pairs *in copula*. Occupied burrows were sometimes within 1 m of one another, but often separated by tens of meters. I made no quantitative assessment of distribution of potential burrows, but several general factors seemed to be involved in their occupation. The flies were not present in older burrows partially filled with soil, or at burrows with entrances blocked by spider webs. In addition, burrows oriented so that they provided no shade in the afternoon were often abandoned during hotter portions of the day.

In Wyoming, burrow-dwelling *Machimus gilvipes* appear to take some prey directly from the walls of the burrow (Schreiber and Lavigne 1986), but in all 16 predations that I observed, prey were taken in mid-air above the burrow. The 43 prey of *M. formosus* included insects from ten families in six orders (Fig. 1): HOMOPTERA, Cicadellidae: *Aceratagallia* sp. (2), *Commellus sexvittatus* (Van Duzee) (3), *Psammotettix lividellus* (Zettinger), unidentified sp. (2 nymphs, 1 adult); HEMIPTERA, Miridae: *Adelphocoris lineolatus* (Goeze); COLEOPTERA, Carabidae: *Harpalus* sp.; LEPIDOPTERA, Pyralidae: unidentified sp.; Tortricidae: unidentified sp. (3); DIPTERA, Anthomyiidae: unidentified sp., Dolichopodidae: *Medetera vittata* Van Duzee (12) (this represents a new state record for this dolichopodid for Montana; Bickel 1985), Scatopsidae: unidentified sp. (6); Sepsidae:

Saltella sphondylii (Schrank); HYMENOPTERA, Formicidae (all alates): *Dorymyrmex insana* (Buckley), *Formica neogagates* Emery, *Formica obtusipilosa* Emery, *Formica subpolita* Mayr.

There seems to be no particular reason for some of the prey (e.g., leafhoppers, moths, and ants) to be associated with mammal burrows, so they probably just happened to come within foraging range of the resident fly. However, the scatopsids and dolichopodids increased their vulnerability by swarming above the burrows which they perhaps used as landmarks. As with *M. occidentalis*, there was evidence of temporal variability in prey records for *M. formosus*. On 18 July 1989, six of seven prey were an unidentified scatopsid fly that swarmed above burrows, whereas on 24 and 25 July, when scatopsids were absent from prey, eight of 11 were dolichopodid flies. Although the size distributions of adults of the two *Machimus* species overlapped, *M. formosus* generally took smaller prey (mean size = 5.7 ± 0.9 mm², N = 41) than *M. occidentalis* (15.8 ± 1.0 mm², N = 106; Mann-Whitney test, $P < 0.001$) (Fig. 1).

Except during mating, the flies apparently occupied burrows alone, tolerating the presence of conspecifics only during mating interactions. Each of the seven times that I observed two non-mating flies at a burrow, one departed when approached by the other, once when butted by the resident. Nine mating pairs were observed on the walls of burrows, all coupled end-to-end. The single complete mating observed was initiated when a female entered a male's burrow and was caught in mid-air by the male; the pair then descended *in copula* to the lip of the burrow entrance where they mated for 7 min and 20 s.

Like many asilids, *M. occidentalis* and *M. formosus* are opportunistic predators whose diets seem primarily determined by their body sizes (relative to potential prey) and by the vagaries of local prey availability. The biology of *M. formosus* is partic-

ularly constrained by the peculiar microhabitat preference that it shares with *M. gilvipes* and *M. polyphemi* Bullington and Beck (Bullington and Beck 1991). The use of burrows by *M. formosus* affects their thermoregulatory strategy (O'Neill and Kemp 1992), as well as their foraging strategy (because their prey base is restricted) and their mating strategy (because mates are available only in one spatially circumscribed microhabitat). However, by occupying burrows, *M. formosus* may minimize its contacts with larger robber flies, such as *Efferia staminea* (Williston), which often prey on smaller asilids, including *M. occidentalis* (O'Neill 1992).

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